

Chapter 6: Other Hazards & Risks

6.1 Introduction

Hurricanes and tropical storms pose major risks to Monroe County due to high winds and flooding (the effects of those storms are addressed in Chapter 5). Other natural hazards addressed in this chapter that affect the area to a lesser degree are high winds other than hurricane (severe storms/tornadoes), rainfall flooding, drought, and wildland fires.

Recent advice from NOAA/NWS is that, although extremely rare, some tsunami hazard exists for the Atlantic and Gulf coasts for elevations less than 15 feet above mean high tide and within 300 feet horizontal distance from mean high tide line. There is anecdotal evidence from a 1755 account of conditions in Havana that were thought to be associated with a hurricane that may possibly have been due to a tsunami wave generated by an earthquake in Lisbon, Portugal. In addition, the U.S. Geology Survey's report on earthquake history of Florida states "In January 1880, Cuba was the center of two strong earthquakes that sent severe shock waves through the town of Key West, Florida." (http://neic.usgs.gov/neis/states/florida/florida_history.html) Because seismic and/or tsunami events have been so rare, they are not further considered in this plan.

Hazards that do not affect the area include landslides/sinkholes, dam/levee failure flooding, and winter storms; thus, these hazards are not addressed by this Plan. Winter storms and freezes do not pose risks to agricultural interests and property because of the climatological and meteorological characteristics of the Keys. The winter of 1981 was especially cold, with temperatures in the low 40°s (record low was 35°F at Coral Key Village). The greatest effect of an unusually low temperature would be a resulting low wind chill factor and the National Weather Service issues wind chill advisories from time to time.

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. The Federal Emergency Management Agency maintains records on federal expenditures associated with declared major disasters. The National Climatic Data Center (NCDC) of the National Oceanographic & Atmospheric Administration collects and maintains certain data in summary format, indicating injuries, deaths, and costs, although the basis of the cost estimates is not identified and the reports are not independently verified (<http://www.ncdc.noaa.gov/oa/climate/severeweather/extremes.html>).

6.2 Severe Storms, Tornadoes & Water Spouts

The term “severe storms” is used to cover weather events that exhibit all or some of these characteristics: high winds (including tornadoes), heavy rainfall, lightning, and hail. Thunderstorms are convective storms produced when warm moist air is overrun by dry cool air. As the warm air rises, thunderhead clouds form and generate strong winds, lightning, thunder, hail and rain. Generally, thunderstorms form on warm-season afternoons and are local in effect. Storms that form in association with a cold front or other regional-scaled atmospheric disturbance can become severe, thereby producing strong winds, frequent lightning, hail, downbursts and even tornadoes.

Of the estimated 100,000 thunderstorms that occur each year in the U.S., only about 10% are classified as severe (produces hail at least $\frac{3}{4}$ inch in diameter, winds of at least 58 miles per hour, or tornadoes).

Thunderstorms produce lightning – a greater threat to people than tornadoes. Lightning is defined as a sudden and violent discharge of electricity from within a thunderstorm due to a difference in electrical charges and represents a flow of electrical current from cloud-to-cloud or cloud-to-ground. Nationally, lightning causes extensive damage to buildings and structures, kills or injures people and livestock, starts many forest fires and wildfires, and disrupts electromagnetic transmissions.

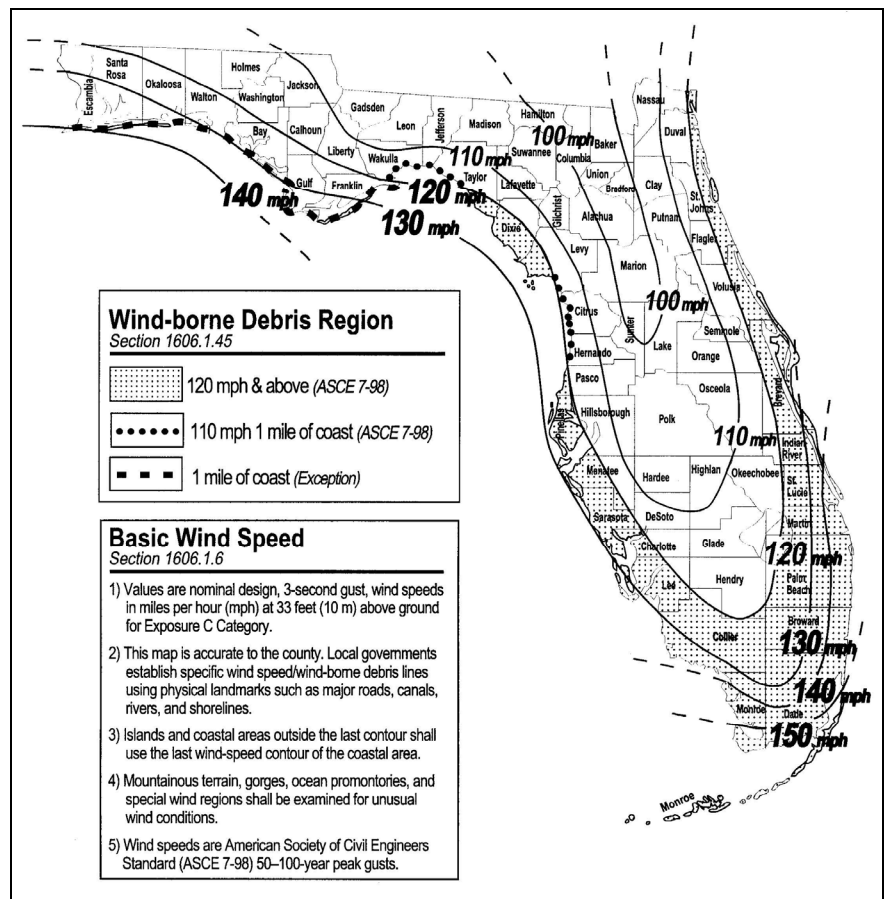


Figure 6-1. Wind-Borne Debris & Basic Wind Speed

Figure 6-1 (on the previous page) shows Figure 1609 from the Florida Building Code (2004 draft) which delineates windborne debris regions and the “basic wind speed” used to design buildings to withstand reasonably anticipated winds in order to minimize property damage. In Monroe County, the “design wind” speed is 159 miles per hour (3-second gust measured at 33 feet above the ground). A probability or recurrence interval is not assigned to the design wind speed.

A tornado is a relatively short-lived storm composed of an intense rotating column of air, extending from a thunderstorm cloud system. Tornadoes may be spawned from storm systems associated with hurricanes and tropical storms. Average winds in a tornado, although never accurately measured, are thought to range between 100 and 200 miles per hour; extreme tornadoes may have winds exceeding 300 miles per hour. The Fujita Scale classifies tornadoes by wind speed and degree of damage (Table 6-1)

A water spout is a violent rotating column of air that touches the water, often resulting from thunderstorms. Waterspouts that come ashore are classified as tornadoes. Fortunately, most waterspouts dissipate over water and do not result in many deaths or serious injuries. However, over water they are a threat to marine interests.

Table 6-1. The Fujita Scale

Scale	Wind Speeds (miles per hour)	Damage	Frequency*
F-0	40 to 72	Some damage to chimneys, TV antennas, roof shingles, trees and windows	29%
F-1	73 to 112	Automobiles overturned, carports destroyed, trees uprooted	40%
F-2	113 to 157	Roofs blown off homes, sheds and outbuildings demolished, mobile homes overturned	24%
F-3	158 to 206	Exterior walls and roofs blown off homes. Metal buildings collapsed or are severely damaged. Forests and farmland flattened.	6%
F-4	207 to 260	Few walls, if any, standing in well-built homes. Large steel and concrete missiles thrown far distances.	2%
F-5	261 to 318	Homes leveled with all debris removed. Schools, motels and other larger structures have considerable damage with exterior walls and roofs gone. Top stories demolished.	Less than 1%

The typical tornado path is relatively short – on the U.S. mainland, paths range from four miles to as long as 300 miles. Path widths average 300-400 yards, but severe tornadoes have cut swaths a mile or more in width, or have formed groups of two or three funnels traveling together. On the average, tornadoes move over land at speeds between 25 and 45 miles per hour, but speeds of up to 70 miles per hour have been reported. Tornadoes rarely linger more than a few minutes over a single spot or more than 15-20 minutes in a 10-mile area, but their short periods of existence do not limit the devastation. The destructive power of the tornado results primarily from its high wind velocities, sudden changes in pressure, and windborne debris. Since tornadoes are generally associated with severe storm systems, they are often accompanied by hail, torrential rain and intense lightning. Depending on intensity, tornadoes can uproot trees, bring down power lines and destroy buildings.

Severe Storm & Tornado Experience and Probability

According to “Florida Hazardous Weather, a Preparedness Guide,” published by the Florida Department of Community Affairs, most tornado deaths occur during the fall, winter, and spring seasons when stronger dynamics are present in the atmosphere capable of producing ‘supercell’/mesocyclone thunderstorms.” The Wind Speed Maps generated through the TAOS model show an equal distribution of winds over the entire area of the Keys for each storm scenario. This demonstrates that the low-lying terrain and narrow islands do not appreciably slow onshore winds.

Based on the NCDC online database, between 1950 and late 2004, numerous events with winds between 50 and 85 knots were reported. Property damage over the 54 year period was reported at less than \$30,000 (not verified) and one death occurred after a boat was capsized.

Florida leads the nation in lightning deaths and injuries, with most occurring from May to October (peaking in July). People near water appear to be at greater risk. Because the Florida Keys are surrounded by water and most tourism and recreation activities are water-based, lightning is a significant hazard (Table 6-2).

Table 6-2. Lightning Deaths/Injuries for Monroe County (1959-2005)

Date	Death	Injury	Remarks
September 1959	0	1	Bridge tender
October 1962	0	1	Unknown
June 1974	1	0	Trash collector in vehicle
July 1976	1	1	Fishing boat

Table 6-2. Lightning Deaths/Injuries for Monroe County (1959-2005)

August 1980	1	0	Fishing from bridge
September 1982	1	1	Snorkeling
June 1983	1	0	Fishing from bridge
August 1986	0	1	Standing under tree
August 1990	0	1	Fishing from boat
July 1995	0	1	Police officer next to car
July 1997	0	1	Unknown
July 2000	0	1	Fishing boat
August 2001	0	1	Restaurant employee
Total	5	10	
Average of 0.1 deaths and 0.2 injuries per year			

Source: NWS Warning Meteorologists, Miami & Key West

Half of tornadoes in Florida occur in the summer months from May through August, but only less than 10% of tornado-related deaths happen during this period of time. Most tornado deaths occur during seasons when stronger atmospheric dynamics may produce supercell/mesocyclone thunderstorms.

Table 6-3 summarizes tornadoes that affected Monroe County from 1959 to 1995 and Table 6-4 lists detail on tornadoes that hit the area between 1996 and 2004. During the 45 year span reflected in the two tables:

- A tornado of intensity F0 or F1 occurs, on average, about once each year; and
- F2 tornadoes, much rarer with only 4 reported associated with two hurricanes, caused most injuries and, by far, the most property damage.

Table 6-3. Tornadoes: 1959 – 1995

Fujita Scale	# Tornadoes Reported	Deaths	Injuries	Cumulative Damage (not adjusted)
F-0	22	0	0	\$153,000
F-1	14	0	11	\$1,058,000
F-2	2	0	40	\$742,000 (both associated with Hurricane Agnes in June 1972)

Table 6-4. Tornadoes: 1996 – 2004

Location Affected	Date	Fujita Scale	Deaths	Injuries	Damage
Key Largo	May 1996	F-0	0	0	
Grassy Key	May 1997	F-1	0	0	\$150,000
Long Key	August 1997	F-0	0	0	
Duck Key	September 1997	F-0	0	0	
Marathon	February 1998	F-1	0	0	\$20,000
Islamorada	February 1998	F-0	0	0	
Key West	June 1998	F-0	0	0	\$15,000
Islamorada	November 1998	F-1	0	0	\$100,000
Rock Harbor	November 1998	F-2	0	0	\$50,000
Key Largo	November 1998	F-2	0	20	\$25 mil
Key West	May 1999	F-0	0	0	
Rick Harbor	September 1999	F-0	0	0	
Craig Key	October 1999	F-1	0	0	
Key West	October 2000	F-0	0	0	
Big Pine Key	July 2000	F-0	0	0	\$15,000
Big Pine Key	August 2000	F-0	0	0	
Key West	October 2003	F-0	0	0	

Source: NCDC online; NWSKW Warning Meteorologist

A significant non-tropical weather event that affected Monroe County was the “Storm of the Century,” a severe, mega-winter storm that occurred from March 12-23, 1993. Moving from Florida’s West Coast across the state and up the eastern seaboard, the storm eventually wreaked havoc from Florida to New England. It brought heavy rains, wind, and coastal flooding to the Southeast and

blizzard-like conditions in the Northeast. When it was finally over, the total damage estimates were over \$800 million (over \$200 million in Florida). The Florida Keys experienced high winds and tides and substantial amounts of rainfall and the County was among the 38 counties declared a Presidential disaster area.

Exposure to Tornado*

Population: 79,589

Residential: \$9.3 million

Commercial: \$2.1 million

Annualized Losses from Tornado **

Total Losses: \$1.7 million

Tables 3.3.7* & 3.5.3**
Florida State Hazard Mitigation Plan (2004)

A particularly active year was 1998, The first event of that year, referred to as the “Ground Hog’s Day Storm,” occurred on February 2, 1998 and involved multiple tornado touchdowns resulting from severe thunderstorms characterized by dangerous cells with high, cold cloud tops. Areas most affected were the Middle Keys including Grassy Key and Valhalla Beach in the vicinity of Duck Key. Several buildings were damaged. Also significant problems occurred from the displacement of lobster traps which contributed to seaborne debris and navigational problems. The fishing industry suffered considerable loss of income.

Another significant weather event occurred on July 4, 1998, when severe thunderstorms with lightning and high winds came up quickly in the Middle Keys. The Key West Weather Service Office recorded sustained wind speeds up to 70 mph. Because it was July 4th, many boats were offshore celebrating and waiting for fireworks displays. One boat capsized, resulting in a fatality. This storm did not prompt a major disaster declaration.

The most damaging tornadoes in 1998 were spawned by Tropical Storm Mitch on November 4 and 5. Islamorada experienced an F-1 tornado, while Rock Harbor and Key Largo were hit by F-2 tornadoes. One tornado moved at 30 mph, tearing down utility lines, damaging boats, and damaging more than 600 structures, many of them were mobile homes.

6.3 Rainfall/Fresh Water Flooding

Flooding due to the accumulation of rainfall generally is not a problem in most of Monroe County and the municipalities because the underlying coral rock and limestone soils have high infiltration rates. The exceptions to this are:

- The City of Key West does experience some freshwater flooding when storm drains cannot handle the volume of runoff and the excess flows through the streets; some low areas do not drain well, resulting in ponding.
- The City of Marathon has identified several locations where ponded water causes access problems and can affect older, non-elevated, buildings.

The most significant rainfall/fresh water flooding event occurred on November 11-12, 1980. The storm resulted in \$1 million in property damage, primarily in the City of Key West. The storm, known as the “Veteran’s Day Storm,” resulted from the influence of a stalled cold front and Tropical Storm Jenne that was over Cuba. These combined systems produced 23 inches of rain in 24 hours, the heaviest 24-hour rainfall ever recorded for the area. Even though the water was pouring out into the neighboring oceans, the intense rainfall resulted in

widespread flooding especially in streets and low-lying areas. Weather Service reports indicated that 300 vehicles and 500 buildings were seriously damaged.

Monroe County Public Works reports that runoff from intense rainfalls generally does not result in road or drainage swale damage, although some unpaved roads exhibit washing and potholes.

6.4 Drought

The 1998 Monroe County Comprehensive Emergency Management Plan defines drought as “a prolonged period of dry weather during which there is an inadequate supply of water to meet water demands.” It continues that, “this prolonged lack of water can have severe effects on people animals, and plants.” It is noted that this situation could result in massive impact to life and property and could severely affect commerce. “Lack of rainfall and adequate water supply could result in health problems for humans, animals, and vegetation. Regulations and water restrictions may force residents to stop the waste of any potable water or water supply”. Drought may be accompanied by prolonged periods of extreme heat.

Drought is a natural and expected part of the climate in most areas, but the severity of drought impacts differs based on duration, geographic extent, intensity, human demand for water, and agricultural practices. Drought can be defined as:

- Meteorological drought, an extended period of dry weather.
- Agricultural drought, a shortage of precipitation that affects crops.
- Hydrologic drought, a reduction in water content in lakes, rivers, streams, aquifers, and soils that may affect supplies available for all users.

The Florida Keys are normally characterized by an arid climate and native vegetation is acclimated to such conditions. However, human usage of potable water continues to rise as development occurs. Situations requiring water usage restrictions have occurred over the last several years:

- The City of Key West imposed water restrictions in November 1990.
- The City of Layton operated under water restrictions in the mid-1990s.
- In 2001 the South Florida Water Management District imposed Phase 1 and Phase 2 water restriction rules throughout the Keys.

Using a simplified approach of occurrence over a given period, for the ten-year period of the 1990s the frequency of drought was 20%. This statement of frequency does not imply severity. Indeed, the Key West Weather Service indicated that drought periods in the Keys

have not been prolonged or widespread and thus drought is not considered to be a significant hazard for Monroe County.

The County is supplied with water from the mainland and all residents are very aware of the need for water conservation on a regular basis, not only during announced drought periods. Typical usage is 169 gallons per person per day during tourist season and 96 gallons per person per day off-season. Measures such as encouraging native vegetation and using native ground cover vegetation in place of lawns contribute to reducing water consumption. Compared to other counties in South Florida, Monroe County's per capita water use is at or below average in most areas.

6.5 Wildland Fire

Wildland fires are defined as an uncontrolled fire spreading through vegetative fuels that exposes and possibly destroys buildings. Wildfires are classified as either wildland (in relatively undeveloped areas, perhaps with some basic infrastructure such as roads, power lines, and railroads) or an urban-wildland interface fire (areas with buildings and development).

Certain conditions must be present for a wildland fire hazard to exist: a large source of fuel; conducive weather (generally hot, dry, and windy) and lack of fire suppression capability due to remoteness or other limitations.

The Monroe County Comprehensive Emergency Management Plan notes that the threat of brush and wildland fires is minimal for the majority of Monroe County. The exceptions are the Everglades National Park in mainland Monroe, and on Big Pine and Sugarloaf Keys in the Lower Keys.

A primary cause of fires is arson, especially vandalism by school age children. Other factors that contribute to fires are high winds and droughts, lightening, carelessness, and accidents. Problems can also occur, especially in storms when downed utility lines may spark fires. Accumulated debris after hurricanes contributes to overall fire potential, including wildland fire potential. After Hurricane Georges in 1998, brush debris caught fire in Big Pine.

Information provided the Florida Department of Forestry indicates that while wildland and brush fires occur infrequently and with little significant consequence in Monroe County, they may occur more often than many think. However, most fires are small and contained quickly. On rare occasion, incidents are more serious. For the most part, fires in the

Everglades do not threaten residential properties although heavy smoke can lead to road closures. Some notable recent events include:

- In the early 1990s, wildfire on No Name Key threatened a few homes.
- Due to very dry conditions, a fire on Big Pine Key in mid-1999 involved 7 acres; although some residences are located in the affected area, no homes were lost.
- Big Pine Key's 2002 wildfire outbreak reached about 6 acres in size and several homes were evacuated.
- A 2003 wildfire in Cudjoe Acres threatened several homes.

The Department of Forestry reports that areas prone to wildland and brush fires in Monroe County include Everglades National Park, No Name Key, Big Pine Key, Grassy Key, Sugarloaf Key, Cudjoe Key, and Big Coppitt Key (including Geiger and Boca Chica). As an indicator of at-risk property in these areas, Table 6-5 indicates the total number of platted lots, the number of lots with improvements, and the value of those improvements. It is important to note that this summary of all properties is not to imply that all properties would be vulnerable in any given wildfire outbreak.

Table 6-5. Summary of Wildfire Risk Areas*

Area	Total # Parcels	# Improved Parcels	Value of Improvements*
Mainland/Everglades	13,736	39	\$1,987,917
No Name Key	504	43	\$8,961,524
Big Pine Key	8,929	2,741	\$444,130,421
Sugarloaf Key	2,284	1,033	\$252,653,244
Cudjoe Key	2,952	1,521	\$251,845,233
Big Coppitt Key (including Geiger and Boca Chica)	2,627	1,289	\$258,465,919
Grassy Key (in Marathon & Key Colony Beach)	9,391	6,498	\$1,562,786,704

* Data from Monroe County Property Assessment (June 2005)

Existing Mitigation Measures. Monroe County has a program for training and certifying volunteer fire departments in wildland fire fighting. Although, the Department of Forestry in the Keys received new equipment in the late 1990s, staff levels have been reduced to only two rangers for all of Monroe County. The following preventive measures are recommended by the Department of Forestry:

- Educational programs, especially for children.

- Clearing of brush, particularly vegetation close to buildings.
- Cleaning gutters to prevent build-up of burnable materials.
- Timely disposal of yard waste and household debris, particularly mattresses.
- Development of ordinances dealing with removal of brush and potentially dangerous vegetative materials, especially during dry spells and during hurricane season, and rapid removal of storm debris.
- When residential property is threatened by fire, the roof and yard should be wet down to provide protection.

To deal with wildfire threats on Cudjoe Key, the Florida Division of Forestry added water supply wells and widened some roads to improve emergency vehicle access.

6.6 Overview of Monroe’s Hazards & Risks

The descriptions of hazards, hazard histories, and impacts are summarized as “relative” vulnerabilities in Table 6-6.

Table 6-6. Hazards: Relative Vulnerability

Hazard	Vulnerability	Impact	Frequency	Distribution
Hurricane/Tropical Storm	High	Moderate to Severe	1-2 per year	Countywide
Flooding (rainfall ponding)	High (locally)	Moderate	6-12 times each year	Key West & Marathon
Tornado	Moderate	Moderate	1-2 per year	Countywide
Wildfire	Moderate	Moderate	Less than 1 per year	Selected areas
Drought	Low	Low	1-2 per decade	Countywide